

**UTILITY PATENT APPLICATION TRANSMITTAL**  
**(Large Entity)**

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Docket No.  
A-6756

Total Pages in this Submission

**TO THE ASSISTANT COMMISSIONER FOR PATENTS**

Box Patent Application  
Washington, D.C. 20231

Transmitted herewith for filing under 35 U.S.C. 111(a) and 37 C.F.R. 1.53(b) is a new utility patent application for an invention entitled:

**ENGINEERED CRACK-RESISTANT PAPER AND BOARD**

and invented by:

**Wadood HAMAD and Bruce LYNE**

If a **CONTINUATION APPLICATION**, check appropriate box and supply the requisite information:

Continuation    Divisional    Continuation-in-part (CIP)   of prior application No.: \_\_\_\_\_

Which is a:

Continuation    Divisional    Continuation-in-part (CIP)   of prior application No.: \_\_\_\_\_

Which is a:

Continuation    Divisional    Continuation-in-part (CIP)   of prior application No.: \_\_\_\_\_

Enclosed are:

**Application Elements**

1.  Filing fee as calculated and transmitted as described below
2.  Specification having 10 pages and including the following:
  - a.  Descriptive Title of the Invention
  - b.  Cross References to Related Applications (*if applicable*)
  - c.  Statement Regarding Federally-sponsored Research/Development (*if applicable*)
  - d.  Reference to Microfiche Appendix (*if applicable*)
  - e.  Background of the Invention
  - f.  Brief Summary of the Invention
  - g.  Brief Description of the Drawings (*if drawings filed*)
  - h.  Detailed Description
  - i.  Claim(s) as Classified Below
  - j.  Abstract of the Disclosure

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**Application Elements (Continued)**

3.  Drawing(s) (*when necessary as prescribed by 35 USC 113*)  
a.  Formal Number of Sheets \_\_\_\_\_  
b.  Informal Number of Sheets \_\_\_\_\_ 2
4.  Oath or Declaration  
a.  Newly executed (*original or copy*)  Unexecuted  
b.  Copy from a prior application (37 CFR 1.63(d)) (*for continuation/divisional application only*)  
c.  With Power of Attorney  Without Power of Attorney  
d.  DELETION OF INVENTOR(S)  
Signed statement attached deleting inventor(s) named in the prior application,  
see 37 C.F.R. 1.63(d)(2) and 1.33(b).
5.  Incorporation By Reference (*usable if Box 4b is checked*)  
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under  
Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby  
incorporated by reference therein.
6.  Computer Program in Microfiche (*Appendix*)
7.  Nucleotide and/or Amino Acid Sequence Submission (*if applicable, all must be included*)
  - a.  Paper Copy
  - b.  Computer Readable Copy (*identical to computer copy*)
  - c.  Statement Verifying Identical Paper and Computer Readable Copy

**Accompanying Application Parts**

8.  Assignment Papers (*cover sheet & document(s)*)
9.  37 CFR 3.73(B) Statement (*when there is an assignee*)
10.  English Translation Document (*if applicable*)
11.  Information Disclosure Statement/PTO-1449  Copies of IDS Citations
12.  Preliminary Amendment
13.  Acknowledgment postcard
14.  Certificate of Mailing  
 First Class  Express Mail (*Specify Label No.*) \_\_\_\_\_

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**Accompanying Application Parts (Continued)**

15.  Certified Copy of Priority Document(s) *(if foreign priority is claimed)*

16.  Additional Enclosures *(please identify below):*

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**Fee Calculation and Transmittal**

**CLAIMS AS FILED**

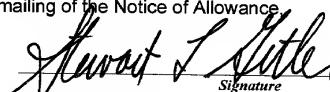
For	#Filed	#Allowed	#Extra	Rate	Fee
Total Claims	17	- 20 =	0	x \$18.00	\$0.00
Indep. Claims	2	- 3 =	0	x \$78.00	\$0.00
<b>Multiple Dependent Claims (check if applicable)</b> <input type="checkbox"/>					\$0.00
					<b>BASIC FEE</b> \$690.00
<b>OTHER FEE (specify purpose)</b> _____					Assignment \$40.00
					<b>TOTAL FILING FEE</b> \$730.00

A check in the amount of \_\_\_\_\_ to cover the filing fee is enclosed.  
 The Commissioner is hereby authorized to charge and credit Deposit Account No. 09-0525 as described below. A duplicate copy of this sheet is enclosed.

- Charge the amount of \$730.00 as filing fee.
- Credit any overpayment.
- Charge any additional filing fees required under 37 C.F.R. 1.16 and 1.17.
- Charge the issue fee set in 37 C.F.R. 1.18 at the mailing of the Notice of Allowance pursuant to 37 C.F.R. 1.311(b).

Dated:

3/9/00

  
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## ENGINEERED CRACK-RESISTANT PAPER AND BOARD

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### BACKGROUND OF THE INVENTION

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The present invention relates to an engineered crack-resistant paper or board, as well to a process of producing the paper and/or board. More specifically, the present invention relates to a crack-resistant, flaw-carrying paper and/or board that will have excellent runability.

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Paper or board being produced with crack resistance, crack retardation, or fracture impedance is a growing requirement for many board or paper coated laminate structures. The structures are formed into various end uses such as containers, board, packaging, ovenable materials, coated paper, and the like. In particular, it is an objective to produce a tougher paper or paperboard.

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There does exist prior patents which disclose various coating layers on base sheets. None are directed to impregnation in geometrical formation.

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U.S. Patent No. 2,515,340 addresses the deposition of a polymer layer over an entire web. The objective of the patent is to make paper and paperboard resistant to wet rubbing and to the coloring of coated paper and paperboard in various selected colors.

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U.S. Patent Nos. 5,004,643; 5,209,964; 5,418,051 and 5,876,792 relate to flexible porous webs which contain an internal coating of a silicone polymer composition. The patents discuss the use of pressurized impregnation methods. These patents focus on process related issues and deal with the "heavy saturation or impregnation with a polymer material" within textile, woven type configurations. They concentrate on encapsulating fibers used for forming webs. They do not discuss or suggest improvements in toughness, or mechanical performance of a cellulose fiber network web. The patents disclose rod-like fibers rather than tube-like fibers, on non-woven networks which are the focus of the underlying invention.

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On the other hand, it is an objective of the invention to engineer paper and/or board capable of providing superior crack resistance or crack retardation mechanisms, thereby enhancing the product's fracture toughness and structural integrity. More particularly, geometric formations in the form of a thin discontinuous thermoplastic or thermosetting polymer film that penetrates a cellulose fiber network to provide islands that serves as a mechanism for crack retardation and fracture impedance.

It is a further objective of the invention to improve the overall mechanical performance of the paper or paperboard, thus impregnated.

It is another objective of the present invention to produce paper and/or board grades with improved runability and with the minimization or elimination of web failures which arise from the presence of defects in paper and the propagation of cracks.

SUMMARY OF THE INVENTION

According to one embodiment of the instant invention, a thin thermoplastic or thermosetting polymer is deposited onto a cellulose fiber network in geometrical formations. The polymer penetrates the cellulose fiber network web to provide islands that serve as a mechanism for crack retardation. The polymer deposition is applied after the web is formed, i.e., in the dry section.

The polymer is laid onto a base sheet in such a way that it forms a discontinuous impregnated film. The polymer penetrates into the base sheet or web to form a uniform paper or board surface to which a subsequent coating may be applied. The coated paper or board can then be printed upon.

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**BRIEF DESCRIPTION OF THE DRAWINGS**

5 **FIGURE 1** is a template used to deposit a polymer material in a geometric pattern on a base sheet; and

10 **FIGURE 2** is an alternate embodiment of a template used to deposit a polymer material in a geometric pattern on a base sheet.

**DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

15 There is disclosed, as a preferred embodiment of the invention, a crack-resistant paper and/or board that has an engineered thin discontinuous thermoplastic or thermosetting polymer material in specific geometric formations impregnated into a cellulose fiber network to provide islands that will serve as a mechanism for crack retardation and fracture impedance. The polymer deposition is applied after the web is formed, i.e., in the dry section. The applied polymer penetrates into the web so as to ultimately form a uniform paper surface to which a subsequent distinct polymer, or other coating may then be applied. The coated paper can then be printed upon. Thus, the invention focuses on crack-resistant base sheets produced through polymer deposition and impregnation, in geometric formations.

20 25 The impregnated polymer is formed in different geometries to reduce weight and maximize crack resistance efficiency. The base sheet thus formed may then be coated, printed upon and used for various or desired end uses.

30 35 Specifically desired is a tougher paper or board which has improved overall mechanical performance. The thin discontinuous thermoplastic or thermosetting polymer is applied in various geometrical formations such as in thin stripes, equidistant circles, and/or diamond shape formations. Other patterns are also within the contemplation of the invention. A very thin layer of the thermoplastic or thermosetting polymer is deposited, no more than 5% of the basis weight of the paper, to the surface of the paper after it has been formed. The polymer penetrates

into the paper or board in these geometrical formations before an additional coating can be applied. The resultant product can be wound on rolls.

5 A circular geometrical pattern as depicted in the template of Figure 1 is one preferred pattern. Specifically, a template is placed on top of a sheet of paper or board and secured in position. A liquid polymeric material is drawn over the template from a well using a brush, scraper, or the like. Accordingly the material will be deposited on the paper or board only at the position of the openings in the template and allowed to dry to provide a discontinuous impregnated film that gives strength to the paper or board.

10 Two principally distinct advantages may accrue from two different geometries as outlined in the cases below.

15 One example of a circular template format has 3mm diameter circles positioned 15 mm apart (center-to-center) to cover the entire sheet. The discontinuous circular reinforcement provides islands that serve as crack arresters or crack retarding mechanisms. Subsequently, the resulting reinforced base sheet possesses an appreciably higher fracture toughness, in both the MD and CD directions. The properties are presented in the table below.

20 Table 1: Results for the non-calendered polymer-impregnated (0.28% solids) base sheets

Sample	Direction	Basis weight (g/m <sup>2</sup> )	Caliper (mm)	Fracture toughness (J.m/kg)	% Increase in fracture toughness
Control (No polymer)	MD	42.9	0.104	21.1	
0.28% solids	CD	42.9	0.104	4.25	
	MD	41.9	0.108	26.9	27
	CD	41.9	0.108	12	182

Table 2: Results for the calendered polymer impregnated (1% solids) base sheets

	Sample	Direction	Basis weight (g/m <sup>2</sup> )	Caliper (mm)	Fracture toughness (J.m/kg)	% Increase in fracture toughness
5	Control (calendered to 556 pli)	MD	42.5	0.063	14	
		CD	41.5	0.063	6.11	
10	1% solids (calendered to 556 pli)	MD	40.5	0.067	23.1	65
		CD	40.5	0.067	8.4	37

The other mechanical properties (tensile strength, elasticity modulus, stretch to break) experience no change between the control and the polymer-impregnated cases (calendered or not), thereby confirming the initial hypothesis that the polymer circular island serve as mechanisms of crack retardation while maintaining the structural integrity of the sheet.

Figure 2 depicts a rectangular template format: The polymer is applied similarly to what is discussed above along 2mm-wide stripes spanning the length of the sheet. A base sheet thus impregnated provides superior ductility in the MD direction and improved fracture toughness in the CD direction (with respect to the control - see above). The values are as follows:

Sample	Ductility - MD (J/g)	Fracture toughness - CD (J.m/kg)
0.28% solids	+42%	+250%
1% solids	+31%	+117%

Again the remaining mechanical properties (tensile strength, stretch, stiffness and elasticity modulus) exhibit no discernible change with respect to the control.

Templates are only one mechanism of depositing the thermoplastic or thermosetting materials onto the board or paper in geometrical formations. Any other mechanism for such is within the scope of the invention.

Materials such as diene-based rubbers which can be produced by emulsion polymerization, namely poly-butadiene, acrylonitrile-butadiene, ethylene vinyl acetate-butadiene and styrene-butadiene are all suitable polymers for the thin discontinuous thermoplastic polymer material. In addition, other polymers such as latex blends, copolymers such as polyhydroxybutyrate and butanoate or cellulose acetate butyrate are also envisioned for the material. Further, it is possible to use various acrylics or polyesters including liquid crystalline polymers for the impregnation material.

Up until the invention described herein, there have been no processes for depositing and impregnating a thin discontinuous thermoplastic or thermosetting material into a dry cellulose fiber network web to serve as toughness and stiffness enhancers with the objective of producing a paper or board grade with trouble free runability. This technique improves runability and minimizes or eliminates web failures arising from the presence of defects in paper and the propagation of cracks.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof, and accordingly, reference should be made to the appended claims, rather than to the limits of the foregoing specification, as indicating the scope of the invention.

**WHAT IS CLAIMED IS:**

5        1. A crack-resistant paper or board comprising a cellulose fiber network web; and a thin discontinuous polymer material impregnated into the web in geometrical formations.

10        2. The crack-resistant paper or board as claimed in claim 1, wherein the thin discontinuous polymer material is a thermoplastic or thermoset material.

15        3. The crack-resistant paper or board as claimed in claim 1, wherein the geometrical formations are thin rectangular stripes, equi-distant circles or diamond-shape formations.

20        4. The crack-resistant paper or board as claimed in claim 1, wherein the polymer is approximately 5%-20% a basis weight of the paper or board.

25        5. The crack-resistant paper or board as claimed in claim 1, wherein the polymer is selected from the group consisting of poly-butadiene, acrylonitrile-butadiene, ethylene vinyl acetate-butadiene and styrene-butadiene.

30        6. The crack-resistant paper or board as claimed in claim 1, wherein the polymer is selected from the group consisting of a latex blend, an acrylic polymer, a polyester resin and a liquid crystalline polymer.

35        7. The crack-resistant paper or board as claimed in claim 1, wherein the polymer is a copolymer selected from the group consisting of polyhydroxybutyrate-butanoate and a cellulose acetate butyrate.

35        8. The crack-resistant paper or board as claimed in claim 1, wherein the paper or board has a polymer material coated on a surface of the paper or board.

9. A process for producing a crack-resistant paper or board comprising the step of:

5 depositing a thin discontinuous polymer onto a cellulose fiber network web and, then having same be absorbed into the cellulose fiber network web, thereby producing a geometrical formation.

10 10. The process as outlined in claim 9, further comprising the step of depositing the thin discontinuous polymer through a geometrical template and onto a formed and dried cellulose fiber network web.

15 11. The process as outlined in claim 9, wherein the geometrical formations are thin rectangular stripes, equi-distant circles or diamond-shaped formations.

20 12. The process as outlined in claim 9, wherein the polymer is approximately 5%-20% of a basis weight of the paper or board.

25 13. The process outlined in claim 9, wherein the polymer is selected from the group consisting of polybutadiene, acrylonitrile-butadiene, ethylene vinyl acetate-butadiene and styrene-butadiene.

30 14. The process outlined in claim 9, wherein the polymer is selected from the group consisting of a latex blend, an acrylic polymer, a polyester resin and a liquid crystalline polymer.

35 15. The process outlined in claim 9, wherein the polymer is selected from the group consisting of polyhydroxybutyrate-butanoate and a cellulose acetate butyrate.

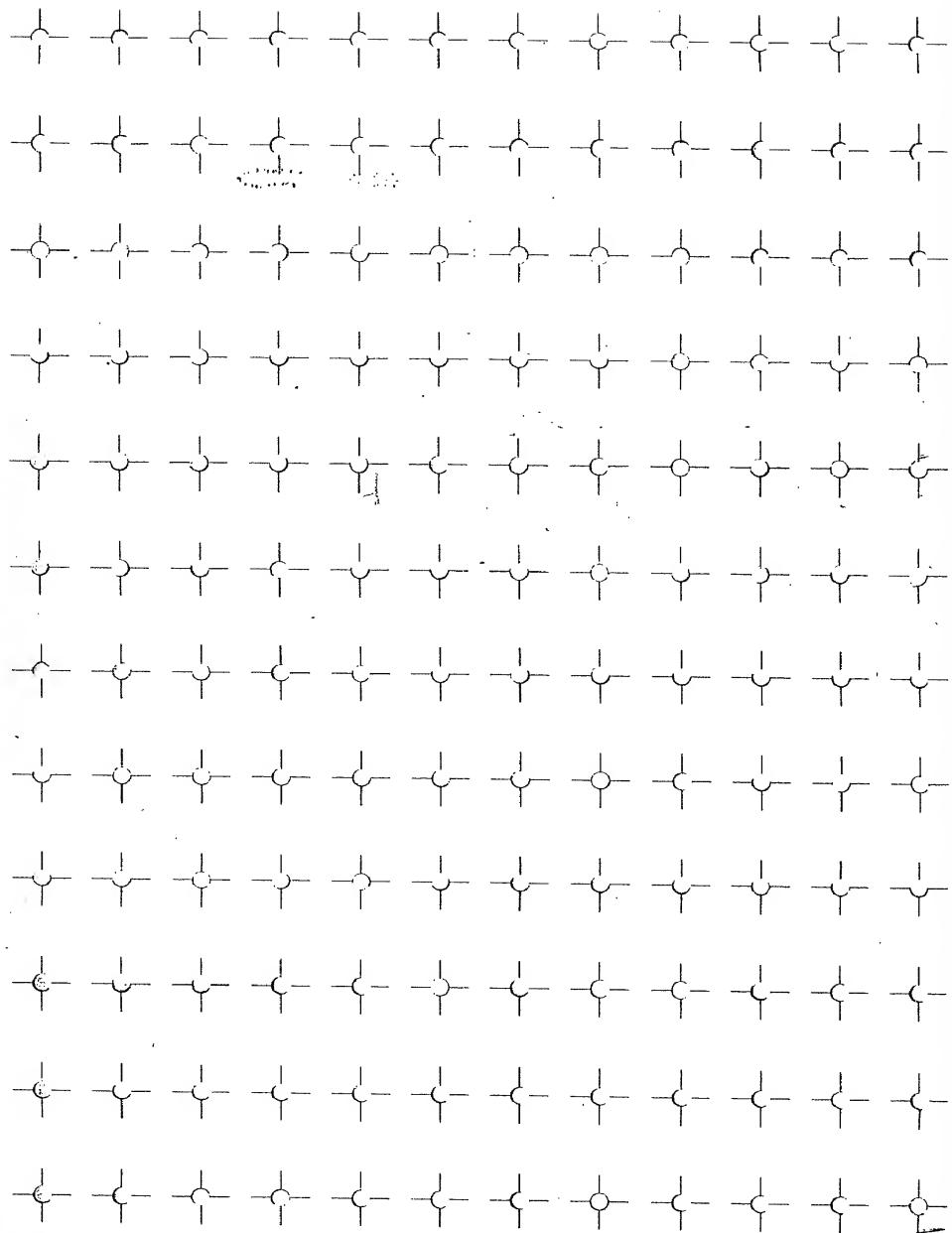
16. The process outlined in claim 9, further comprising the step of coating a polymer onto the formed crack-resistant paper or board to produce a coated paper or board network.

17. The process outlined in claim 16, further comprising the step of printing on the coated paper or board network.

**ABSTRACT OF THE DISCLOSURE**

5 An engineered crack-resistant paper or board for improved runability formed by depositing a thin discontinuous thermoplastic or thermosetting polymer onto a cellulose fiber network web and having same absorbed into the network in specific geometrical formations. The base sheet thus formed may then be used for various end uses such as packaging, containers, plates, cups, low-weight coated printing grade boards or the like.

FIGURE 1



2  
PRED

Docket No.

A-6756

# Declaration and Power of Attorney For Patent Application

## English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

### ENGINEERED CRACK-RESISTANT PAPER AND BOARD

the specification of which

(check one)

is attached hereto.

was filed on \_\_\_\_\_ as United States Application No. or PCT International Application Number \_\_\_\_\_

and was amended on \_\_\_\_\_

(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

### Prior Foreign Application(s)

Priority Not Claimed

(Number)	(Country)	(Day/Month/Year Filed)	<input type="checkbox"/>
(Number)	(Country)	(Day/Month/Year Filed)	<input type="checkbox"/>
(Number)	(Country)	(Day/Month/Year Filed)	<input type="checkbox"/>

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional

(Application Serial No.)

(Filing Date)

(Application Serial No.)

(Filing Date)

(Application Serial No.)

(Filing Date)

I hereby claim the benefit under 35 U. S. C. Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C. F. R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

(Application Serial No.)

(Filing Date)

(Status)  
(patented, pending, abandoned)

(Application Serial No.)

(Filing Date)

(Status)  
(patented, pending, abandoned)

(Application Serial No.)

(Filing Date)

(Status)  
(patented, pending, abandoned)

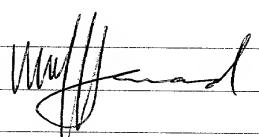
I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

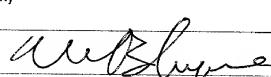
**POWER OF ATTORNEY:** As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

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